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Ruth Milkman, Chief
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Federal Communications Commission
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Re: *Amendment of Part 27 of the Commission's Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band* (WT Docket No.07-293) -- NOTICE OF WRITEN EX PARTE PRESENTATION

Dear Mr. Knapp, Ms. Milkman and Ms. De La Torre:

In a recent meeting with representatives of the Wireless Telecommunications Bureau, the International Bureau and the Office of Engineering and Technology, the WCS Coalition expressed its serious concerns regarding the staff's proposal to impose new duty cycle requirements on mobile devices operating in the WCS band, particularly when coupled with a reduction in the current maximum authorized power of mobile devices, an absolute bar on any mobile operations in the 5 MHz of WCS spectrum closest to the satellite DARS band, and the imposition of new restrictions on out-of-band emissions below 2305 MHz and above 2360 MHz. As the WCS Coalition explained in that meeting, the net result of these limitations would be to effectively preclude the use of the WCS spectrum for viable mobile broadband – 180 degrees opposite of the intent of the National Broadband Plan.

The record does not support the need to impose any restriction on the duty cycle of mobile devices that are otherwise limited to a maximum of 250 milliwatts of power and required to utilize transmit power control. To the contrary, when the WCS Coalition conducted the only real world testing utilizing an operational WCS system, it demonstrated that, save for one isolated instance, a mobile device operating with a 37% duty cycle over a 5 MHz channel at 250 milliwatts did not cause interference to DARS reception, not even when that operation was as close as 2.5 MHz from the DARS band edge. Yet, despite this evidence, the staff proposal would limit the duty cycle to 12.5% in the outer C and D block, 25% in the lower B and upper A blocks and 35% in the lower A and upper B blocks.

At that meeting, the WCS Coalition committed to provide the Commission with a third-party analysis of the proposed duty cycle requirements as they applied to WiMAX 802.16e deployments. The Coalition retained TeleWorld Solutions ("TeleWorld"), a leading consulting firm with substantial experience in the implementation of WiMAX 802.16e technology, to provide a report addressing the implications for WCS deployments were the staff's suggestions to be adopted. That report is attached. As you will see, TeleWorld has reached four fundamental conclusions:

- TeleWorld confirms that the ratio of the maximum mobile duty cycle is an important system parameter that is critical to the efficient allocation of time and network resources to manage contending traffic demands. It notes that while there are a number of different duty cycle ratios available for use by 802.16e WiMAX systems, it is common for commercial systems to allocate approximately 38% of each frame to uplink ("UL") transmissions to maximize throughput based on known user traffic patterns and customer experience expectations. TeleWorld provides an analysis establishing that more restrictive duty cycle requirements will compromise the user experience, and overly restrictive duty cycles will not permit users to realize broadband throughput.

- TeleWorld establishes that TDD wireless broadband systems are not designed to employ changes in the mobile duty cycle as a means of reducing interference potential to nearby services, and if used in this manner, a series of problems with system implementation and throughput are introduced. Specifically,

    - TeleWorld confirms that an 802.16e system operator effectively will be required to reduce its mobile operations to meet the lowest duty cycle assigned to any of the channels. This means, for example, that an A block licensee seeking to utilize both its upper and lower channels would have to operate with the 25% duty cycle assigned to its upper A channel. Similarly, a B block licensee would be constrained to the 25% duty cycle assigned to its lower B channel. And any system seeking to employ the outer C and D block segments would be required to constrain the performance of all mobile devices to 12.5%.

    - Further compounding the impact on UL performance, TeleWorld reports that only a limited number of duty cycles are supported by the vendor community. There is no support for the recommended 12.5% duty cycle. Thus, the entire C and D blocks will not be available for mobile use if the staff's proposal is adopted. And, because there is no support for the 35% duty cycle, operators would be required to limit mobile operations to the 24.96% duty cycle that is the closest available, which does not violate the 35% limit. This will not change unless and until vendors decide to support a duty cycle that has no utility elsewhere in the world, and because adding additional duty cycles cannot be implemented with simple software changes, the WCS Coalition fears that vendors will not support "one off" duty cycles for the very limited U.S. WCS market.

- Imposing specific duty cycle requirements as proposed by the FCC staff has the additional unintended consequence of limiting the ability for certain wireless broadband technologies to be used in the WCS bands. The proposal is 802.16e specific because the 5 ms frame used for measurements will effectively limit the ability of operators to deploy TD-LTE, or even next generation WiMAX. In addition, it would make future deployment of frequency division duplex technologies impossible. The net result is that, as TeleWorld puts it, the staff's proposal "may tend to skew technology decisions away from those that best serve the marketplace absent a duty cycle requirement and towards those that happen to best yew toward arbitrary duty cycle limits."

For these reasons, the WCS Coalition urges the staff to abandon its proposal for using duty cycle as a mechanism for controlling interference between WCS and satellite DARS. The other restrictions on WCS use – an absolute ban on mobile use of the 5 MHz closest to the DARS band, power limits, and mandatory transmit power control have been proven more than adequate to provide Sirius XM with the reasonable level of interference protection to which its customers are entitled. Crippling WCS as a source of mobile broadband spectrum to provide Sirius XM with "belt and suspenders" interference protection cannot be squared with the Commission's pronouncements that Sirius XM is not entitled to absolute interference protection from WCS.

Pursuant to Sections 1.1206(b)(1) and 1.49(f) of the Commission's Rules, this letter is being filed electronically with the Commission via the Electronic Comment Filing System.

Should you have any questions regarding this presentation, please contact the undersigned

Respectfully submitted,

Paul J. Sinderbrand

Counsel to the WCS Coalition

Attachment

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Impact of Proposed Duty Cycle Limitations on WCS Mobile Broadband Systems

I. Introduction

The staff of the Federal Communications Commission (FCC) has recently shared its preliminary recommendations for new technical rules to govern operations in the adjacent Wireless Communications Service (WCS) and Satellite Digital Audio Radio Service (SDARS) spectrum allocations in the 2.3 GHz band. One of the staff's proposals was the imposition of duty cycle limitations on WCS mobile devices as a means of reducing interference from these devices to SDARS mobile receivers. This paper provides background on the use of the allocation of system capacity to downlink (DL) and uplink (UL) communications and the resulting maximum mobile duty cycles in Time Division Duplex (TDD) wireless broadband systems, such as WiMAX and TD-LTE, as well as an analysis of the impact of the FCC's proposals on the ability of WCS licensees to provide mobile broadband services. It concludes that:

- The DL/UL ratio of a TDD wireless broadband system, along with the resulting maximum mobile duty cycle, is an important system parameter that is critical to the efficient allocation of time and network resources to manage contending traffic demands;
- While there are a number of different duty cycle ratios available in IEEE 802.16e WiMAX wireless broadband systems, it is common for commercial systems to be set at the network level to allocate approximately 38% of each frame to UL transmissions to maximize throughput based on known user traffic patterns and customer experience expectations;
- TDD wireless broadband systems are not designed to employ changes in the mobile duty cycle as a means of reducing interference potential to an adjacent channel or service, and if used in this manner, a series of problems with system implementation and throughput are introduced;
- Imposing specific duty cycle requirements as proposed by the FCC staff has the additional unintended consequence of limiting the ability for certain wireless broadband technologies to be used in the WCS bands.

II. Background on Use of Duty Cycle in Broadband TDD Systems

The DL/UL ratio, which drives the maximum duty cycle of a mobile device, is a parameter of TDD wireless broadband systems, such as WiMAX or TD-LTE, which is used to efficiently allocate system capacity and thereby maximize throughput. Allocating a somewhat greater proportion of capacity to downlink communications takes into account the known imbalance of Internet-based data communications, where there is usually a greater number of downlink than uplink packets. The amount of time allocated for uplink communications sets the theoretical maximum amount of time any given mobile device can be transmitting within the measurement timeframe. An under-allocation of system

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resources to a mobile device will result in a reduction in the transmission speeds realized by any single user or, in the case of a highly loaded system, all users of the network.

Using the TDD 802.16e WiMAX frame structure for 5 MHz or 10 MHz wide channels as an example, an understanding of the relationship between UL/DL split and the resulting mobile duty cycle can be had. The physical layer is based on a 5ms frame structure, which is split into four parts. Two parts, one part for the DL and the other for the UL, are useable for operational traffic. These two sub-frame portions are separated by two buffers, referred to as the Transmit Transition Gap (TTG) and the Receive Transition Gap (RTG). The TTG is the time between the end of the DL portion of the frame and the commencement of the UL portion – it provides a brief interval to accommodate propagation delay and assure that the base station signal is received by the mobile before the mobile switches to transmit mode. Similarly, the RTG is the time between the end of the UL portion of the frame and the commencement of the DL mode, allowing time for transmissions by mobile devices to be received by the base station before the base station begins transmitting. The combined length of the RTG and the TTG is 165.714 µS.

The maximum amount of time that a TDD WiMAX mobile device can possibly operate in the UL mode is dependent on the number of symbols within the frame allocated to UL communications. In a TDD 802.16e WiMAX 5 MHz or 10 MHz channel deployment, there are 47 symbols, spanning 102.857µS per symbol, within the 5ms frame. One of these symbols is always occupied by the Preamble (which is treated as a DL symbol), leaving 46 symbols for use by either UL or DL traffic. When the number of symbols allocated to the UL is multiplied by the 102.857 µS length of each symbol and converted into a ratio of time over the 5ms frame, it establishes the maximum mobile device transmit time (or duty cycle) within a given frame. In a commercial system, this split between UL and DL symbols is determined at the network level to optimize network resources to handle asymmetrical traffic loads.

It is important to note that this symbol allocation, and the resulting maximum mobile device duty cycle, is not infinitely adjustable. Based on analyses of typical use patterns, only a handful of DL/UL symbol allocation configurations have been implemented by WiMAX equipment vendors, which are presented in the table below.

DL Symbols (including Preamble)	UL symbols	Maximum UL Duty Cycle
35	12	24.69%
32	15	30.86%
29	18	37.03%
26	21	43.20%

Table 1. UL and DL splits in commercially available WiMAX systems.

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III. Impact of the Proposed Duty Cycle Limitations on Mobile Broadband Services

Were the proposed duty cycle limits adopted, there are several significant unintended consequences that will have a direct impact on the ability of WCS licensees to offer mobile broadband services.

a. The proposed limitations will cause deployment delays and limit spectrum usage

As an initial matter, the specific mobile device duty cycle limitations proposed for each of the WCS blocks are not currently supported by any wireless broadband standard developed for the 2.3 GHz band. Adoption of the proposed limitations will result in two possible outcomes: 1) delay in the deployment of mobile broadband equipment in the 2.3 GHz band as vendors work through the standards development process to define new profiles to accommodate the unique U.S. market requirements; and/or 2) the under-utilization of certain blocks for mobile broadband services because the duty cycle requirements preclude viable service offerings.

For example, under the proposed duty cycle limitations, the outer 2.5 MHz of the C and D block spectrum (farthest from the SDARS band edges) will not be immediately usable for mobile communications because the proposed 12.5% duty cycle is not supported by any mobile broadband standard. Moreover, operators employing the lower A block and/or the upper B block – the spectrum farthest from the SDARS allocation – would not be able to operate with the proposed 35% duty cycle, but instead would be relegated to the next lowest implemented duty cycle of 30.86% given that this is the next closest option currently supported by vendors that does not exceed the FCC staff's proposed limitation for those blocks.

Compounding matters, the proposal to apply different maximum duty cycle requirements to the lower A/upper B blocks (35%), the lower B/upper A blocks (25%), and the outer 2.5 MHz of the C/D blocks (12.5%) will require a system operator utilizing multiple blocks to limit the mobile duty cycle to the lowest common denominator. In other words, any system that includes the lower B or upper A spectrum is limited to 25% mobile duty cycle, and any system that includes any spectrum from the outer 2.5 MHz of the C or D channels is limited to 12.5% mobile duty cycle. The same holds true if the lower A, B and C blocks (or the upper blocks) were combined in whole or in part. The lowest common denominator would dictate the duty cycle of all of the blocks.

It is because the segregation of a TDD frame into an UL/DL split must be consistent network wide that the use of multiple frequency blocks in a single system results in a default to the lowest duty cycle specified for any of the blocks. In any TDD system, there is common baseband hardware that acts as the timing source at each base station to assure that all of the devices in the network are synchronized to operate in DL mode at the same time and to operate in UL mode at the same time. This synchronization is essential for two reasons: (1) it prevents the self-interference that would otherwise occur when one

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sector is in the DL mode while a nearby sector is in the UL mode; and (2) it makes possible the handoff of a mobile session from one sector to another.

Were there not this synchronization, closely spaced sector antennas could be subject to high level RF signals from neighboring antennas. For example, if the TDD transmit time of all sectors is not identical, then one sector may transmit at the same time that its neighboring sector receives. Due to proximity, the receiving sector would be subject to significant power from the neighboring antenna, resulting in overload. The potential for this problem to occur was recognized by the 2.5 GHz EBS/BRS licensees, resulting in the adoption by the Wireless Communications Association International of an industry-wide best practice recommending that all EBS/BRS systems utilize a common timing reference and a common DL/UL split in order to avoid intersystem interference.[1]

Moreover, without the synchronization made possible by a consistent DL/UL allocation, mobile devices would be unable to listen to, communicate with or coordinate a handoff to a neighboring sector or site. This would lead to the need to manually disconnect and reconnect a device to force it onto the sector or cell with a different frame structure – eliminating the ability to offer mobility as part of the service. Therefore, synchronization is imperative for any TDD mobile broadband system implementation, making it impossible for a network operator to apply different duty cycle limitations to different frequency blocks within the same system.

Given that equipment vendors are supporting only a limited number of DL/UL splits, which are different from those suggested by the FCC staff for the 2.3 GHz band, as well as the need for a common timing source in TDD systems, adoption of the proposed duty cycle limitations will result in a delay in the deployment of mobile broadband equipment and ultimately in the under-utilization of certain WCS blocks for mobile broadband services.

b. System throughput will be severely limited by the proposed duty cycle limitations

As mentioned previously, a limited number of duty cycle configurations, designed to accommodate typical user traffic patterns, are supported by WiMAX equipment vendors. The most commonly recommended symbol allocation for commercial WiMAX systems is a DL/UL ratio of 29/18. According to the WCS coalition, this was the configuration set for the out-of-the-box WiMAX equipment used in the Ashburn WCS-SDARS demonstration. Applying a 29/18 split will result in the theoretical maximum UL duty cycle of about 37.03% measured over the WiMAX frame. The choice of duty cycle has a direct impact on perceived customer experience – the lower the UL duty cycle, the lower the throughput from a mobile device. Mobile broadband service providers must select a system-wide duty cycle that they deem an appropriate balance between traffic demands and user experience expectations.

[1] This synchronization plan is available at http://www.wcai.com/images/docs/2008/wcai_synchronization_plan.pdf.

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The graph below roughly illustrates the effect of duty cycle adjustments on UL throughput. Drive tests of a commercial WiMAX network, operating with a 37% UL duty cycle and using a 10 MHz wide channel, were conducted to collect data about the UL throughput along the drive route. The results of this data collection were averaged to show the typical user experience over the coverage area of a site. Since the collected data was gathered using a 10 MHz channel, it was necessary to extrapolate the UL throughput in narrower channels. The 10 MHz wide channel UL throughput was reduced by half for a 5 MHz channel and by ¾ for a 2.5 MHz channel. This is not a perfect extrapolation due to the fact that overhead in a channel is constant regardless of the channel bandwidth, which results in the actual throughput of smaller channels being somewhat less than what this extrapolation predicts. Similarly, the DL/UL split of the commercial WiMAX network was known, enabling extrapolation of the throughput to different DL/UL splits. The result of these extrapolations yielded the plot below.[2]

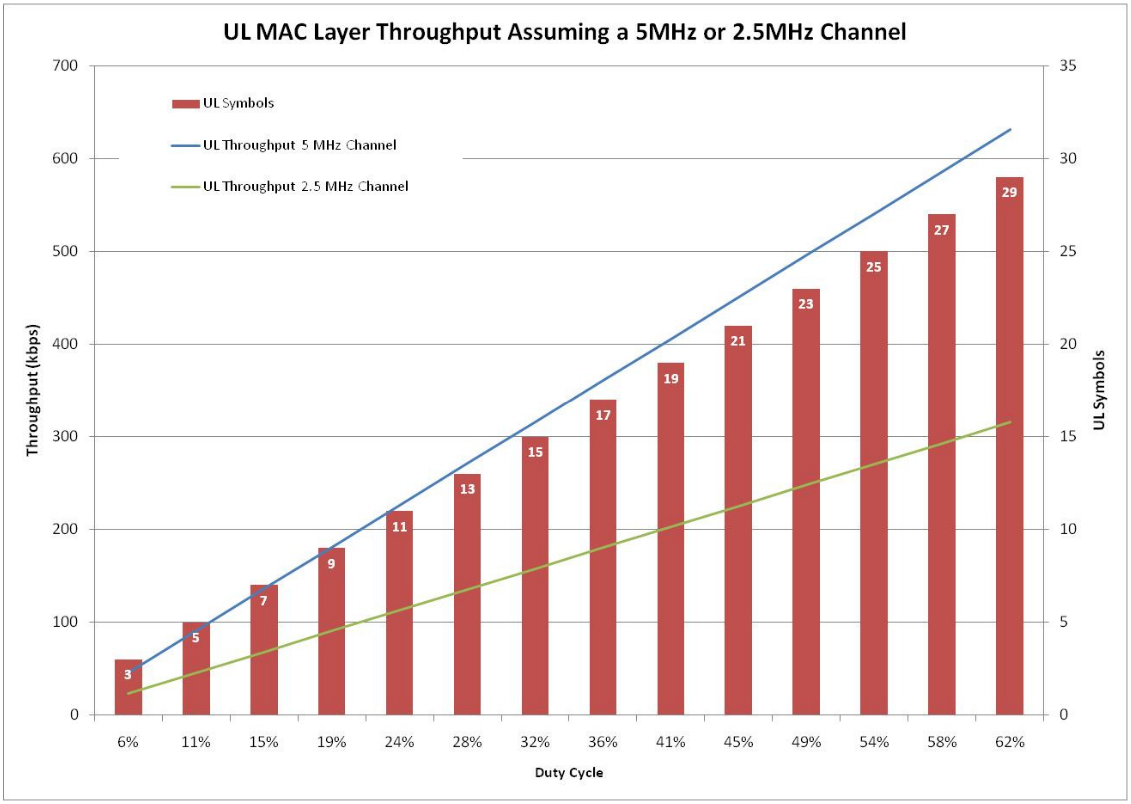

Figure 1. Approximate relationship between duty cycle and UL throughput in a commercial WiMAX system.

[2] The majority of the duty cycle limitations shown in this graph are not supported by any commercial equipment vendors are used for illustrative purposes only. Similarly, no commercial WiMAX equipment is available for a 2.5 MHz wide carrier.

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As shown in the Figure 1 above, even if the vendor community were to make the necessary changes to the standards profiles and equipment to support the duty cycles under consideration, enforcing the 12.5% duty cycle on an operator that has only 2.5 MHz of spectrum available for mobile operations in either the C or D blocks results in a theoretical average user UL throughput of only 50 kbps, which is slower than dial-up speeds. Even applying a 35% duty cycle to a 2.5 MHz channel results in a theoretical average user UL throughput of about 150-200kbps, which again is not a value proposition that a broadband customer will accept over time. It should be further noted that system throughput numbers will most certainly go down as users are added to the network and resources are shared by a larger community.

c. Specifying duty cycles and the measurement period will limit technology choice

Imposing specific duty cycle limitations and measurement durations for the WCS band will have a direct effect on the technologies that can be deployed in the band.

First, as mentioned in previous sections, commercially available WiMAX equipment currently supports only four different duty cycle settings. Other wireless broadband technologies that are being developed for the 2.3 GHz band, such TD-LTE, employ duty cycle settings that are dissimilar to the four WiMAX options. Therefore, limiting the duty cycle settings as proposed will likely result in the need for revisions to one or both the WiMAX and TD-LTE standards and profiles before equipment could be deployed in all but the lower A and upper B WCS blocks. It also may tend to skew technology decisions away from those that could best serve the marketplace absent a duty cycle requirement and towards those that happen to best yew toward arbitrary duty cycle limits.

Second, different wireless broadband standards and systems have different frame structures, which makes a specific duty cycle measurement period problematic. For example, the specifications for 802.16e WiMAX call for a 5ms frame structure, the 802.16m WiMAX standard calls for 2.5ms, whereas LTE standard calls for 10ms. There may be other frame structures adopted as technology development progresses. Were a 5ms measurement period adopted, it would be highly unlikely that a technology with a shorter or longer frame structure could meet the mobile duty cycle requirements. UL symbols are not distributed evenly within a frame. Therefore, a 5ms measurement of a frame with a different duration could result in as little as 0% and as much as 100% of the UL symbols within the frame being captured during that particular 5ms period, making impossible an equitable application of a specific duty cycle limitation to different technologies. As such, a measurement period of any specific length of time will instead result in limiting the types of technology that can be deployed in the WCS bands to those with the same frame duration as the measurement period.

Third, adoption of mobile transmit duty cycle limitations as proposed would preclude the deployment of FDD systems in the WCS bands given that in an FDD system certain blocks are likely to have a 100% duty cycle for mobile transmissions. While only TDD equipment has been developed for the 2.3 GHz band to date, limiting the band to one or the other technology could have the unintended consequence of impeding technology development and enhancement.

IV. Conclusion

For the reasons set out in this paper, adoption of the FCC staff's preliminary duty cycle proposal will have a variety of unintended, adverse consequences for the 2.3 GHz WCS band:

- The C and D block spectrum allocation will be rendered useless for the provision of service at true broadband speeds, even in the portions 2.5 MHz removed from the SDARS band, because the duty cycle is so low.

- The upper B and lower A spectrum – spectrum that is 5 MHz removed from the SDARS band -- will not be useable unless and until vendors support a new DL/UL split, and even then will only be able to provide consumers with marginally acceptable speeds if bound to other spectrum.

- The lower A and upper B spectrum – spectrum that is 10 MHz from the SDARS band – will be hampered by the mandate of a non-standard UL duty cycle unless and until vendors support the DL/UL split under consideration, and even then will be limited in the speeds that can be achieved.

- The proposed duty cycle rules would adversely impact the ability of WCS licensees to select the technology best suited to marketplace needs and to evolve as new technology choices become available.

- The duty cycle requirements imposed for mobiles will also adversely impact the ability of system operators to deploy fixed stations as well. Because the system must operate in a fully synchronized manner, it will be impossible for operators to offer fixed services over the same network with higher uplink data rates, notwithstanding the fact that such fixed units are highly unlikely to be utilized in close proximity to SDARS receivers.